Physics Tomorrow Letters
2020; 06(05): 03-02
https://www.wikipt.org/material.sci/vol-three
doi: ptl.dxdoi.com/07-02msci

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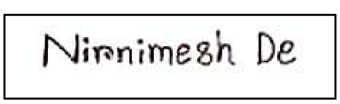
REVIEW | MATERIAL SCIENCE LETTERS



BIBLIOGRAPHY

I have minutely studied and researching for solution of Water crisis and the other crucial crisis for over six months. I have investigated various techniques and process in this area but this processes have no diversity to solve other crisis like Energy Crisis, Global Warming, Environment Pollution mainly Air and others. I am very interested in the various fields of Physics, Chemistry, Environmental Science, Thermo-Fluid Science, Material Science especially in Nanotechnology, Nano Magnetic Fluid, and Interdisciplinary also. I , a student of Mechanical Engineering and a Senior Scholar of JBNSTS, have also studied on different topics related to Programming, Computational Fluid Dynamics, MATLAB and Simulation Software etc. Further, I am also interested in Bioscience & Microbiology and studying on the Factors that influence Human Behavior and characters, Psychoactive drugs influencing CNS etc.

https://ptl.dxdoi.com/07-02msci
ptl.dxdoi.com/07-02msci

Sea Water-The Source of Solutions of Modern-Day Water and Other crucial Crisis

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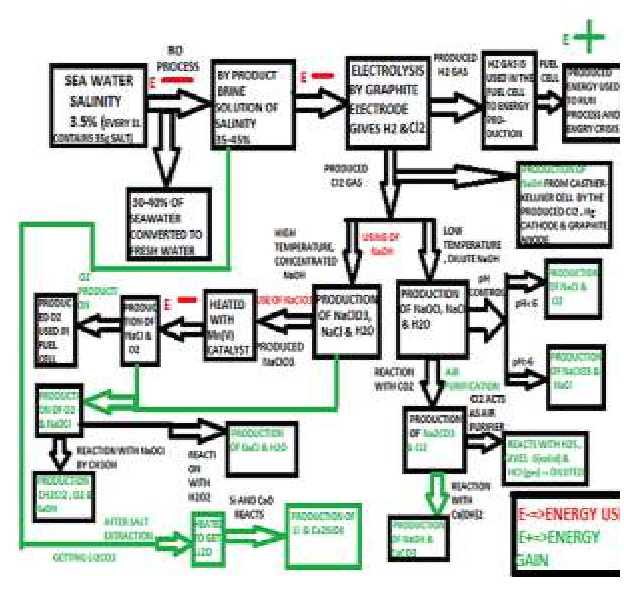
Abstract

Water scarcity is the most crucial problem around the Globe. It is because of two converging phenomena: Growing of fresh water use and Depletion of usable freshwater resources. The Millennium Development Goals within the United Nations, Millennium Declaration stated that by 2015 they resolve to "halve the proportion of people who are unable to reach or to afford safe drinking water". In this case the seawater can be the source of the crucially needed "Drinking water" but still it has to be purified for that. For this matter , an idea can be presented for making not only drinking water but also producing H_2 and O_2 gas by which we can generate electricity , scavenge the essential metals found in the seawater and also can be used to purify air i.e. to decrease the air pollution. Also it can produce its own needed materials by which the processing can be done. So it is a user friendly process as well as Source of production of the crucial materials (like lithium). So it can be the one type of the solution for the water crisis as well as the Air Pollution controlling which are the important aspects for Human life and broadly for our Earth to protect Future Generation.



Flow Diagram of the Complete proposed Process to solve critical crisis (Water Crisis, Energy Crisis, Environmental Pollution Crisis and others…)

Keys: Reverse Osmosis; Adsorption; Disproportionation; NanoCrystals; Graphene.

1 Introduction

Extensive environmental pollution caused by Worldwide Industrialization and population growth has led to a serious water crisis. Currently, ~1.2 billion people around the world are suffering from a shortage of water and its adverse consequences on health, food and energy. On one hand, population growth, increased industrialization and greater energy needs and on the other hand, loss of snowmelt, shrinkage of glaciers, Global Warming, Environment Pollution and so on will worsen this situation in upcoming years. As estimated by the World Water Council, the number of affected people will rise to 3.9 billion in the coming decades. So in order to solve these problems, Drinking water can be produced from the Sea as Seawater comprises a vast supply of water (97.5% of all water on the planet). State-of-the-art water purification necessitates the implementation of novel materials and technologies that are cost & energy efficient along with Eco-friendly Way to protect our Earth and Future generation. "The concept of water shortage may also refer to the difficulty in obtaining freshwater sources and the deterioration and depletion of avail-able water sources" (Sharma & Bharat 2009). Seawater is the major source of our drinking water, and also by this proposed theoretical process, crucially needed electricity, drinking water and extraction of costly rare Earth metal (i.e. Lithium) can be produced and this process it will be more economically safe for our society and beneficiary for our Earth also. In this process, the generated hydrogen gas can be used as fuel and the oxygen gas for life supporting issues and other most important needs in our day to day Modern life. As such this proposed theory will be the best idea to tackle the Grave problems in our modern society as well as producing an infinite and steady supply of high-quality water that does not harm natural freshwater ecosystems as well as the environment.

2 General principal of production

The following steps have to be followed in order to make this theoretical idea successful .These steps are:-

The commercial and easiest process of desalination of Seawater is "Reverse Osmosis", but this process generates the by-Product i.e. Brine (30-35% of salinity approximately). So our proposed process starts with the use of this by- Product (Brine), to produce drinking water and other crucial needs.

1) In this process, first Graphite electrode has to be used for electrolysis of the brine, producing Hydrogen (H_2) in the Cathode (-electrode) which is very crucial material as it can be used as fuel along with, in the Anode (+ electrode), the Chlorine gas (Cl_2) is produced. It is very toxic and not very helpful for solving the water crisis except its chlorination property to purify water. But it can be used in different way to produce a lot of crucial materials and Drinking Water.

2) Secondly, taking the generated Cl_2 gas from anode, it has to passed through the NaOH (Sodium Hydroxide) filled chamber. In the chamber, which two different types of can control the temperature and the concentration of NaOH, critically needed chemical reactions can be performed between NaOH and Cl_2 gas.

3) Thirdly, at high temperature, concentrated NaOH reacts with Cl_2 which is a "Disproportionation reaction", producing $NaClO_3$ (Sodium Chlorate), NaCl (Sodium Chlorite), and the H_2O (water). $NaClO_3$ can be separated from NaCl by a Separation method. In this way, purified water can be produced. $NaClO_3$ can be heated upto 300 degree Celsius, then it gives NaCl and O_2 .As a result of this process, the pure O_2 is evolved as well as drinking water, NaCl and $NaClO_3$.$NaClO_3$ can be used in solid welding system. It has been seen that the heating of $NaClO_3$ takes heavy energy. There is a solution of this drawback, the heat energy i.e. consumed in this process, can be generated by oxidation of small amount of Fe (Iron) mixed with $NaClO_3$ and that consumes less amount of O_2 than production. So it is an Energy Solving process. As NaOH is very costly, our proposed idea gives a unique solution to produce it again. The solution is the Castner-Kellner Cell producing NaOH from brine which can be produced from NaCl and the seawater. Seawater has a salinity of 3.5%, but brine is needed upto 26% salinity, so the salinity level can be increased with mixing of the produced NaCl with the seawater. In this process, NaOH is produced for further processing as well as the H_2 & O_2 gas as produced that can be used for production of pure drinking water. This procedure is very helpful as it generates energy and water vapour i.e. condensed to Liquid Water as the chemical reaction of H2 and O2 is exothermic (deltaH= -ve) in nature. The novelty of this particular process/Chemical Reaction is that it can be used in the fuel cell to produce electricity. The hydrogen as produced in this process can be transported by the Occlusion (i.e. the process of adsorption of H_2 in Palladium (Pd)). It makes easier to transport the Hydrogen Gas.

4) In step four, by controlling temperature and concentration of NaOH in the chamber, Cold and dilute NaOH reacts with Cl2 which is also a "Disproportionation reaction" , that results the production of NaOCl (sodium hypochlorite), NaCl (sodium Chloride) and water. NaOCl can also be separated from NaCl by Separation method which previously discussed in step three. This process results the production of drinking water. The aqueous solution of NaCl and NaOCl that is produced in this step, named as "Milton solution" can be used in Bleaching powder Production. We can also use the KCl solution treated with NaCl, and then mixed it with the $NaClO_3$ solution. This chemical reaction results the forming of KClO3 as white PPT and in the solution there is the rest of NaCl, which can be separated by evaporation method.

5) In fifth step, by controlling the pH level, different products can be evolved from NaOCl like that, by pH above 6, hot NaOCl decomposes to NaCl & $NaClO_3$, also by the pH below 6, it gives NaCl and O_2 .So it can be a better source of NaCl , $NaClO_3$ and the major O_2 production which can be used for many crucial purposes.

6) Sixth step, the Purpose of production of NaOCl: The main application of NaOCl is to purify the air by scrubbing CO_2 from it. It reacts with CO_2 in Air and also forms Na_2CO_3 & Cl_2 gas, still it is dangerous as it emits Cl_2 gas. However, Nano-hexagonal shaped crystals of NaOCl molecule can be designed to build the primary structure (i.e. perforated plate form) of the sieve plate. This Sieve plate is installed in the chimney of industries, the silencers of cars and motorbikes from where the smoke can be passed out through it. The smoke contains the CO_2 (Concentration 10-25% per volume) reacts with NaOCl molecule and produces the Cl_2 that reacts with other toxic elements in the smoke .The reactions are like H_2S (forming Sulfur(s)), Lead(Pb) (forming $PbCl_2$ (s)) , Sulfur (S) (forming SCl_2) , aluminum (Al)(forming $AlCl_3$) , Cadmium(Cd) (forming $CdCl_2$) , Copper (Cu)(forming $CuCl_2$) , Nickel (Ni) (forming $NiCl_2$) , Chromium (Cr)(forming $CrCl_2$), Mercury (Hg) (forming $HgCl_2$) and etc. It can also be used mostly in the petroleum refinery where the emission of poisonous H_2S gas along with CO_2 gas takes place. Thus using this Nano-sieve plates of NaOCl, results the first reaction with CO_2 to produce Na_2CO_3 and Cl_2.Then all the chemical reactions that take place are the same which described above. Na_2CO_3 can be used in glass, paper, rayon, soaps and detergent manufacturing. The produced Cl_2 gas can be used to react with H_2S producing Sulfur(S) and HCl (Hydrochloric acid).This Sulfur can be used for vulcanization of black rubber, in black Gun powder and also for H_2SO_4 production. The produced HCl can be used in refining metal industries, pickling of steel, in regeneration of ion-exchangers and many reactions of NaOCl with CO_2 in presence of H_2O. This chemical reaction produces $NaHCO_3$ which can be used to make baking powder, Pyrotechnics for "Black Snake" firework. Radioactive waste can be removed by $NaHCO_3$ like Uranium would be washed out by 2% solution of Sodium Bicarbonate. It is the unique use of $NaHCO_3$ as clothing can become contaminated with toxic dust of depleted Uranium (DU), which is very dense, i.e. used for counterweights in a civilian context and in armour- piercing projectiles. The above reaction also produces HClO which can be used as preservative for saline solution.

3 Experimental Equations and Graphs

3.1. Brine solution

Brine is a high-concentrated solution of salt in water. In different context, Brine may refer to salt solutions ranging from about 3.5% up to about 26% (a typical saturated solution, depending on temperature). Lower levels of concentration are called by the names: fresh water, brackish water, saline water. The brine solution, we are using here for electrolysis, is highly concentrated and likely more or less near the saturated point of the salt in the solution. As we know, depending on temperature, the saturation point also moves like at 373K temperature, it is near about 28%, at 298K temperature it becomes about 26.7% and at 273K temperature it is about 25%. So, the temperature of the system has to be controlled efficiently in order to maintain the solution saturated.

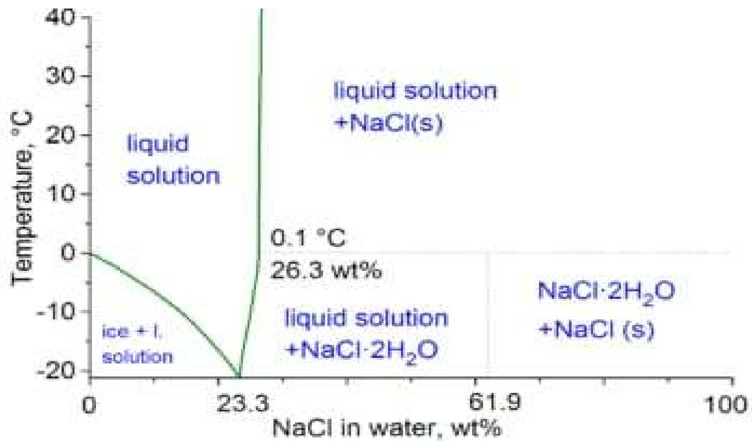


Figure 2 | Phase diagram of Brine solution.

Despite that sea water contains many components like Mg/Ca/K/Sr/Ba salts so these components should be separated before using, by different separation method. Brine contains more than 100000 mg/L TDS (Total Dissolved Solids). Here is the table showing the different composition of Brine solution.

Table 1 | *Composition of Brine Solution*

Cations	ppm	Anions	ppm
Sodium	8,615	Chloride	12,000
Magnesium	22	Bicarbonate	1,900
Calcium	280	Sulfate	80
Potassium	170	Acetate	1,500
Strontium	25		
Barium	27		

3.2. Equations involved and reaction facts using Graphite Electrode of Brine Solution

At first, there is a small amount of H^+ and OH^- ions in the system due to the self-ionisation process of water. As the reaction proceeds H^+ is taken away from system forming H_2 and the equilibrium of reaction shifts towards right, resulting increment of OH^- concentration.

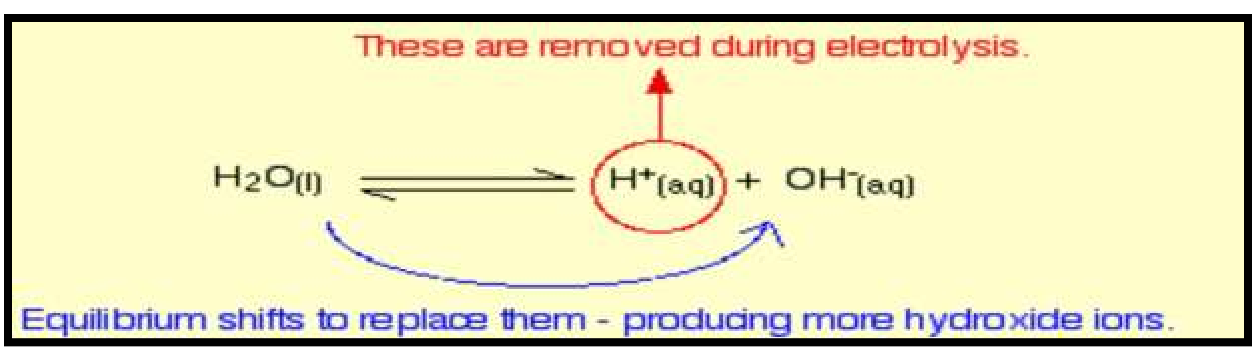


Figure 3 | Equilibrium Shifting During Electrolysis

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3.2.1. Anode reaction

$2Cl^- \rightarrow Cl_2 + 2e^-$

Both OH^- and Cl^- can be discharged in anode but due to more energetically favourable process [ΔG = -ve more for Cl_2/Cl^-half cell] , discharge of Cl^- is proceed before OH^-.

3.2.2. Cathode reaction

$2H_2O + 2e^- \rightarrow 2OH^- + H_2$

Here also Na^+ and $H^+(/H_2O)$ both can be discharged. But, $E^0_{Na^+/Na}$ =-2.7144 V, $E^0_{H_2o/H_2}$ =1.23 V.

We know that, $\Delta G = -nFE^0_{cell}$

So, for only $E^0_{H_2O/H_2}$, ΔG =-ve so the H_2 production becomes thermodynamically favourable process.

In this process of electrolysis, the side reactions can also be taken place:-

$2NaOH + Cl_2 \rightarrow NaOCl + NaCl + H_2O$

$2OH^- + Cl_2 \rightarrow 2OCl^-$ (hypochlorite) $+H_2$

$2NaOCl \rightarrow 2NaCl + O_2$

$4OH^- \rightarrow O_2 + 2H_2O + 4e^-$ (may occur at anode in small extent)

So, discharging of NaOH solution always contains some amount of NaCl which can be separated by crystallization or fractional distillation.

Here, in the electrolysis, Redox reaction proceeds as Cl^- reduces $H^+(H_2O)$ to H_2 and it oxidizes it's own to form Cl_2.

However this process is somehow dependent on pH of the solution so certain pH must be maintained to make this Redox reaction feasible.

$Cl^- - e^- \rightarrow \frac{1}{2} Cl_2$

For this reaction,

$E = E^0 + 0.0591*\log [Cl^-]$ {as for convention $[Cl_2]$= 1}

Where, $E^0_{Cl^-/Cl_2}$ =1.36V

So, it is pH independent.

But, $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

So, for this reaction

$E = E^0 - 0.0591/2*\log[OH^-]$ { as for convention P_{H_2} =1 , $[H_2O]$= 1 } {$E^0_{H_2O/H_2}$ = 1.23V}

Or, $E = 1.23 + 0.0591*P_{OH}$

Or, $E = 1.23 + 0.0591*(14 - pH)$

Or, $E = 2.0574 - 0.0591*pH$

So, for neutral water at 298 K temperature, pH =7

So, E = 1.6437 V > $E^0_{Cl-/Cl2}$ (1.36V)

According to calculation, in pH= 11, $E^0_{H2O/H2}$> $E^0_{Cl-/Cl2}$

So to keep condition intact for oxidation of Cl^- and reduction of H_2O to H_2, the pH must be maintained upto 11 or below using suitable buffer condition.

3.3. Advantage of this Process

In the conventional Desalination process, the simplest way to dispose un-polluted Brine after RO/FO from desalination plants and cooling towers, is to return it to the ocean. However, this process may pose an environmental risk due to its corrosive, toxic & sediment forming effects. Therefore, it requires wastewater treatment for proper disposal or further utilization, which is very costly as well as energy taking process. The Brine solution i.e. discharged from these types of plants , has more or less 20-23% of salt saturation, so at first stage, adequate amount of NaCl has to be mixed with it, to make a saturated Brine solution and use it as the electrolyte of the electrolysis process. This reaction results H_2 at first. Later, the decomposition of $NaClO_3$ or NaOCl will produce O_2 under controlled temperature and pH respectively. By fusing of H_2 and O_2, fresh drinking water is produced with **ZLD** (**Zero Liquid Discharge**).

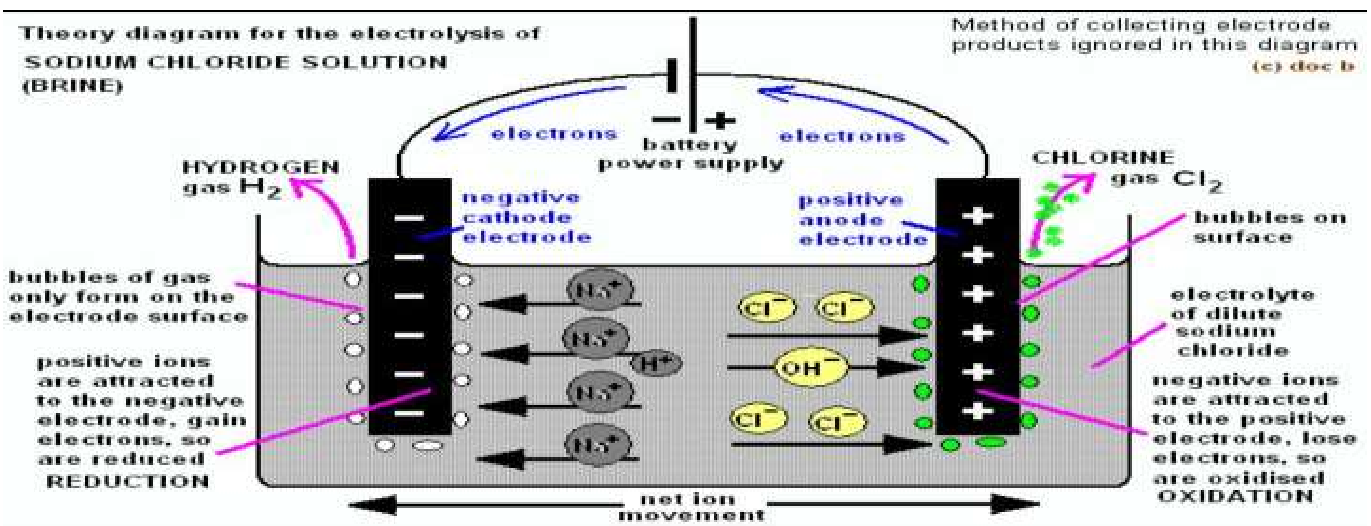


Figure 4 |Electrolysis by Graphite Electrode in Brine solution

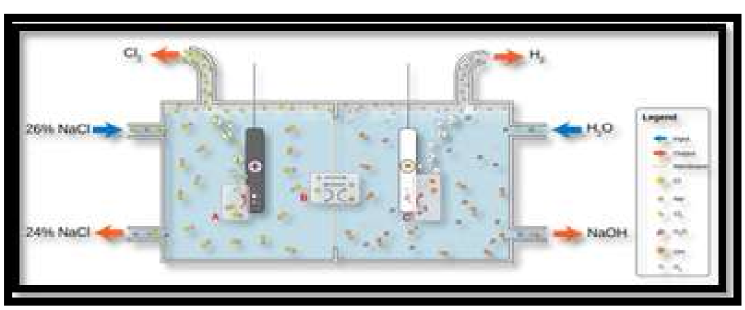


Figure 5 |Electrolysis Reactions of Aqueous NaCl solution (source from https://courses.lumenlearning.com/boundless-chemistry/chapter/electrolysis/)

Electrolysis of aqueous sodium chloride: Electrolysis of aqueous NaCl results in hydrogen and chloride gas. At the anode (A), chloride (Cl^-) is oxidized to chlorine. The ion-selective membrane (B) allows the counter-ion Na+ to freely flow across, but prevents anions such as hydroxide (OH^-) and chloride from diffusing across. At the cathode (C), water is reduced to hydroxide and hydrogen gas. The net process is the electrolysis of an aqueous solution of NaCl into industrially useful products Sodium Hydroxide (NaOH) and chlorine gas.

- The reaction at the cathode is:

$H_2O(l)+2e^-\rightarrow H_2(g)+2OH^-$; $OH(l)+2e^-\rightarrow H_2(g)+2OH^-$

- The reaction at the anode is:

$Cl^-\rightarrow(1/2)Cl_2(g)+1e^-$---→$Cl^-\rightarrow(1/2)Cl_2(g)+1e^-$

- The overall reaction is as follows:

$NaCl(aq.)+H_2O(l)\rightarrow Na+(aq.)+OH^-(aq.)+H_2(g)+12Cl_2(g)$

- Reduction of Na+ (E° = –2.7 v) is energetically more difficult than the reduction of water (−1.23 v).

There is the 2nd reaction of Chlorine gas with different concentration and temperature NaOH.

1) Hot Concentrated

$6NaOH$ (aq.) + $3Cl_2$ (g) ----------------------------------→$5NaCl$ (aq.) + $NaClO_3$ (aq.) + $5H_2O$ (l)

(Sodium Chlorate (v))

2) **$2NaClO_3$ (s) ------near about 250degree Celsius ----------→$2NaCl$(s) + $3O_2$ (g)**

Manganese (v) oxide used as catalyst in this reaction

The 3rd most important reaction is to regenerate the NaOH by the following reactions:-

3) At the Graphite Anode in Castner-Kellner cell :

Cl^- (aq.) ----------------------------→Cl_2 (g) + e- (electron)

At the mercury cathode in the outer cells is:

Na+ (aq.) + e- --------------------→Na (amalgam)

The Anode reaction in the center cell takes place at the interface between the mercury and the sodium Hydroxide solution.

doi: ptl.dxdoi.com/07-02msci

2 Na (amalgam) --------------→ $2Na^{+} + 2e^{-}$

Finally at the iron cathode of the center cell the reaction is:

$2H_2O + 2e^{-}$ --→ $2OH^{-} + H_2$

4) **$2H_2O$ (g) + O_2 (g) -----------------------------→ $2HO^{-}$ (aq.) + 241.8KJ energy**

(95% by volume) (4% by volume)

5) Hydrogen fuel Cell reaction producing Electricity :

H_2 (g) + O_2 (g) -------------→ H_2O (aq.)   deltaGf = -229KJ/mol

H2 ------------------------------→ $2H^{+} + 2e^{-}$ $E_0 = 0.00V$

O_2+ 4e- + $4H^{+}$ --------------→ $2H_2O$ $E_0 = 1.23V$

3.3.1. Effectiveness of Fuel Cell

The performance of a fuel cell is governed by its "Polarization Curve". This type of performance curve shows that the DC voltage is delivered at the cell terminals as a function of the current density (current per unit area of membrane) which is being drawn by the external load. This curve and the losses associated with its shape will be discussed below (Figure 6). One measure of the energy conversion efficiency of a fuel cell is the ratio of the actual voltage at a given current density to the maximum voltage obtained under no load (open circuit) conditions.

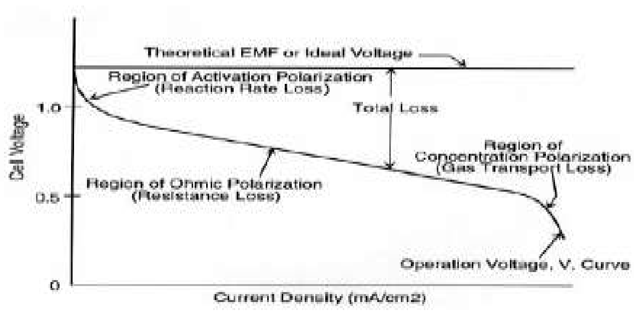


Figure 6 | Polarization Curve of a typical Fuel Cell

In Cold and Dilute NaOH reacts with Cl2 which is also a "Disproportionation reaction" resulting NaOCl (sodium Chlorate), NaCl (sodium Chloride) and Water. NaOCl can also be separated from NaCl by a Separton Method. This process results the production of drinking water and the aqueous solution of NaCl and NaOCl called as Milton solution can be used in Bleaching powder production.

Chemical Reaction

Cold Dilute Condition of NaOH

$2NaOH$ (aq.) + Cl_2 (g) --------------→$NaCl$ (aq.) + $NaOCl$ (aq.) + H_2O (l)

(Sodium Chlorate)

By controlling the pH level, different products can be produced from NaOCl like that by pH above 6 , hot NaOCl decomposes to NaCl and $NaClO_3$ and by the pH below, it gives NaCl and O_2. So it can be a better source of NaCl, $NaClO_3$ and the major O_2 production. This O_2 can be used for many purposes.

Chemical Reactions

$6NaOCl$ (s) ------------------pH above 6----------------→$4NaCl$(s) + $2NaClO_3$ (s)

$2NaOCl$ (s) -------------------pH below 6 ---------------→$2NaCl$ (s) + O_2 (g)

6) Then the major step of reaction which is the Air Purification process.

Chemical reactions:

$NaOCl$ (s) + CO_2 (g) -------------------→Na_2CO_3 (s) + Cl_2 (g)

H_2S (g) + Cl_2 (g) -------------------→S (s) + HCl(g)

The above two reactions are most important for reducing Environmental Air-Pollution Reducing Technique.

$NaOCl$ (aq.) + CO_2 (g) + H_2O (l)---------→$NaHCO_3$ (aq.) + $HClO$ (aq.)

At room temperature; This reaction produces(Saturated solution of (Hypochlorous Sodium Bicarbonate) Acid)

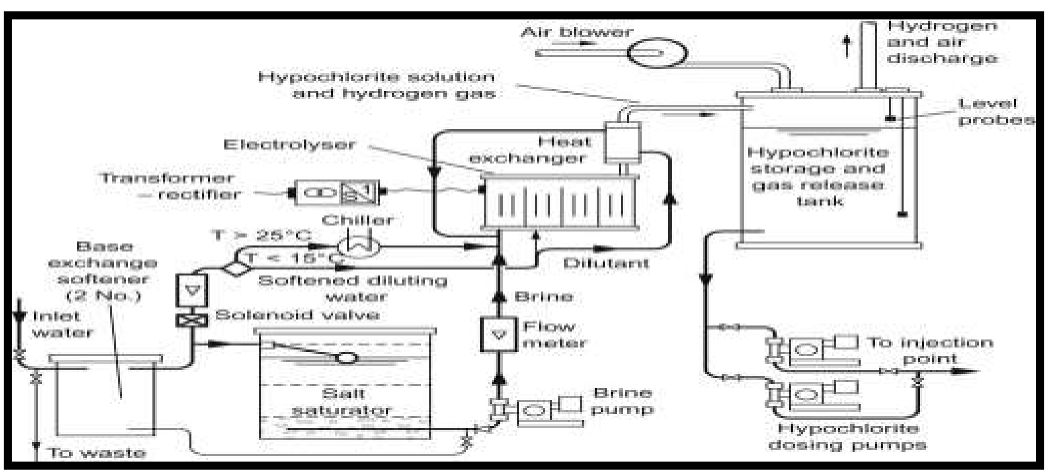


Figure 7 |On-site Hypochlorite production from Brine

7) Then comes the crucial aspect, the oxygen gas regeneration process:-

$NaCl (s) + O_3 (g)$ -------------------→ $NaOCl (s) + O_2 (g)$

8) Other important reactions to be produced

$4NaOCl (aq.) + 2CH_3OH(aq.)$ ----------------→ $2CH_2Cl_2(aq.) + 4NaOH(aq.) + O_2(g)$

$NaOCl (s) + H_2O$ -----------------------------→ $HOCl (aq.) + OH^{-}(aq.)$

$2HOCl (aq.)$ ---------Heavy metal cations------------→ $2HCl (aq.) + O_2 (g)$

$NaOCl (aq.) + H_2O_2 (aq.)$ -----------------------→ $NaCl (aq.) + H_2O$

9) Production of Bleaching Powder in an innovative process with low cost

$CaCO_3 (s)$ ------heated upto 1173K----→ $CaO (s) + CO_2 (g)$

$CaO (s) + H_2O (l)$ -------------------------→ $Ca(OH)_2$ + delta H= -64.5KJ/mol

$NaOH (aq.) + CO_2 (g)$ -----------------------→ $Na_2CO_3 (aq.) + H_2O (l)$

$Na_2CO_3 (aq.) + Ca(OH)_2$ ------------------→ $2NaOH(aq.) + CaCO_3(s)$

$Ca(OH)_2(aq) + Cl_2 (g)$ -----at 313K-----→ $Ca(OCl)Cl + CaCl_2 + H_2O$
(Bleaching Powder) Production Reaction;

$2Ca(OH)_2(s) + 2Cl_2(g)$ ----at low temperature--→ $Ca(OCl)_2(s) + CaCl_2(s) + H_2O(l)$

$Ca(OH)_2(s) + Cl_2 (g)$ ------at high temperature-→ $Ca(ClO_3)_2 (s)+CaCl_2 (s) + H_2O (l)$

10) Most important metal *Lithium metal extraction Process*

$Li_2CO_3 (s)$ ---------------heat---------------→ $Li_2O (s) + CO_2 (g)$

$2Li_2O$ (s) + Si(s) + 2CaO(s) ------------------------→4Li(s) + Ca_2SiO_4(s)

delta G1000= -351KJ

$3Li_2O$ (s) + 2Al(s) + CaO (s) ---------------------→6 Li (s) + $Ca(AlO_2)_2$

Delta G298= +81KJ

Here is the graph (Figure8 Shown) showing that Graphite electrode is most suitable for hydrogen gas production. For that our proposed theory is performed by Graphite electrode for maximum output possible from this process.

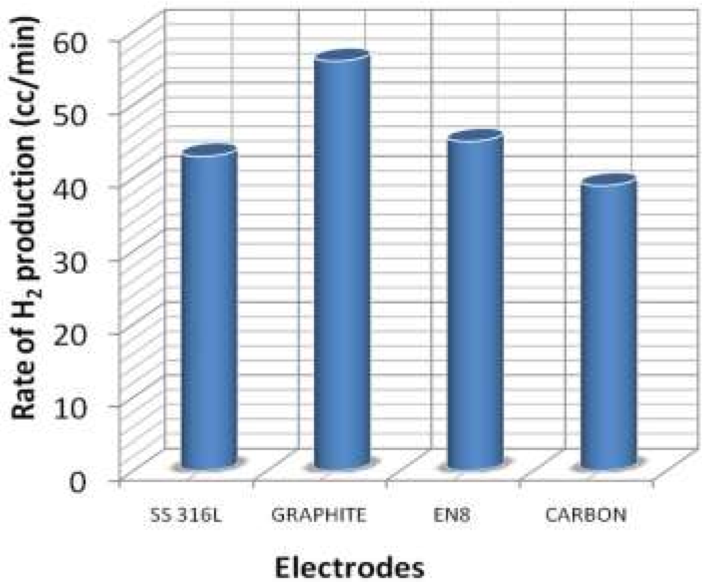
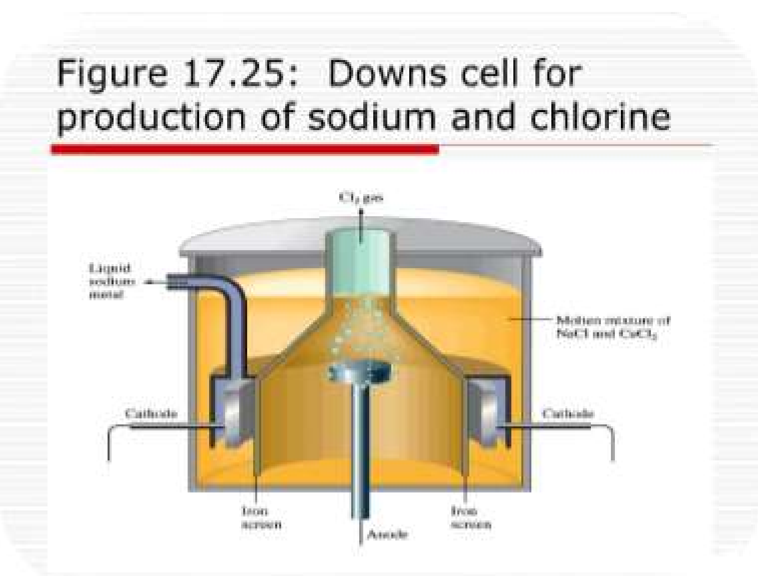


Figure 8 | Graph showing Graphite Electrode maximum H_2 production



The Downs cell has been introduced (Figure9 shown) for production of Sodium Metal that is very valuable and chlorine gas that is used to run the process. It is easiest process for solving the water crisis problems.

Figure 9 | Downs cell i.e. the Production of Na & Cl_2

This process helps to produced the reacted component in the reactions so it is one type of auto-cyclic process, once the process starts it produces it's own reactants with valuable by-products as a result of the reaction.

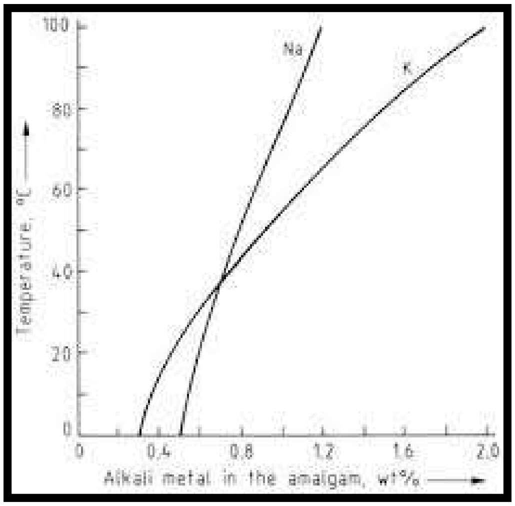


Figure 10 | Graph of Na production

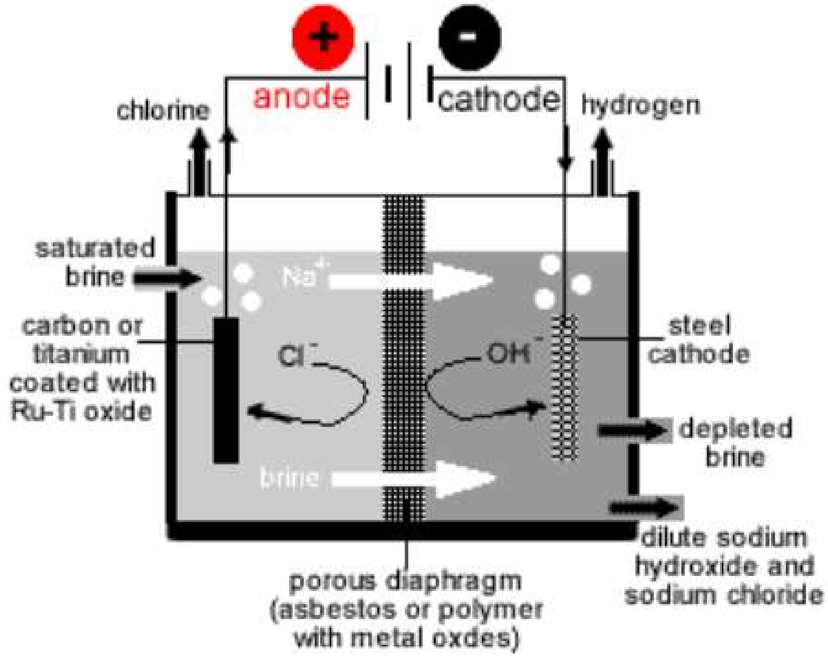


Figure 11 | Special Castner Cell of Ru-Tx Oxide as Anode to minimize Hg use

This Graph (Figure 10) shows, how Sodium metal production is dependent on temperature and the Castner-Kellner cell reaction with Amalgam.

There is another way, by not using the Mercury for Castner-Kellner Cell, if we can use Titanium coated with Ru-Ti oxide as Anode, Steel cathode and porous diaphragm (Figure11 shown). It will be an eco-friendly process to produce hydrogen and chlorine gas with minimum Electricity consumption. It is not affecting the Environment, than the conventional Castner-Kellner Cell (Hg here used as Cathode) (Figure12 shown) as it does not use the Hg.

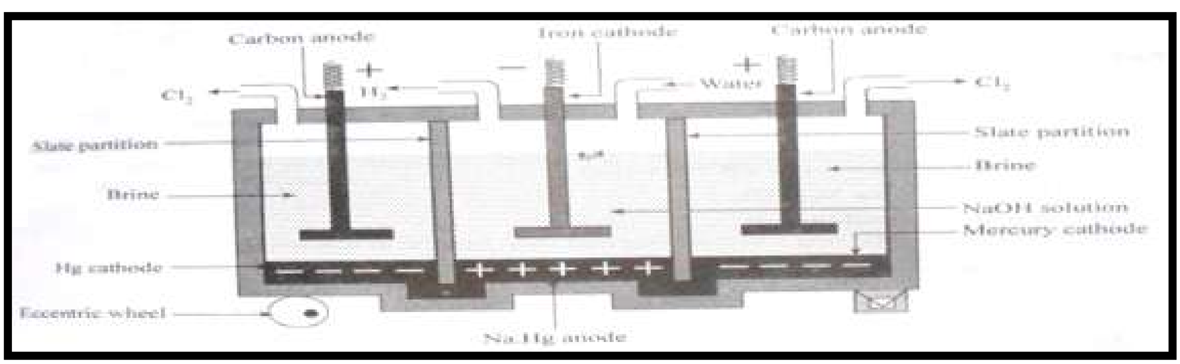


Figure 12 | Graph of Na production With Conventional (Hg used as Cathode) Castner-Kellner Cell

Separation technique of NaOH/Cl_2& H_2/Cl_2

If H_2 & Cl_2 reacts, the reaction may be explosive and can harm the electrolysis setup. Again, if NaOH and Cl_2 reacts that may give rise to a side reaction forming NaOCl and HCl which can also enhance the rate of O_2 (unwanted by-product) formation.

We can solve this problem by using diaphragm cell which has asbestos separation to separate these products. But diaphragm to some extent also inhibits the formation of NaOH (increasing the side reaction of O_2 formation).

To solve this problem, Membrane cell (figure 13 shown) can be used as a alternative way. There is considerable interest, in using thin synthetic plastic membrane instead of asbestos in diaphragm. These membranes are made of a polymer called Nafion, supported on a Teflon mesh. Nafion is a co-polymer of Tetrafluoroethylene and Perfluorosulfonylethoxyether. Plastic membranes have a lower resistance than asbestos. This membrane allows only positive ions to pass through it. That means only the Na^+ ions from NaCl solution can pass through the membrane and not the Cl^- ions.

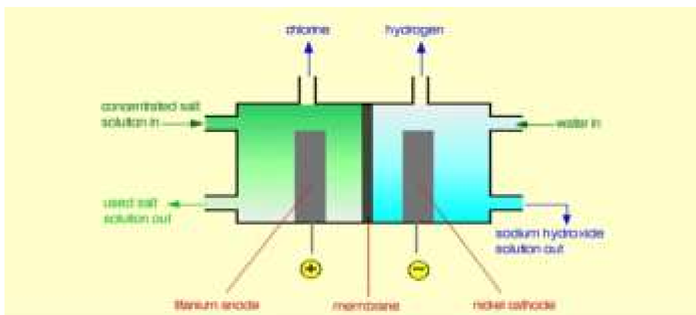


Figure 13|Membrane Cell

The advantage of this process , is that NaOH solution being formed in the right hand compartment, never gets contaminated with any NaCl solution.(Figure 13)showing the Membrane cell for using.

The NaCl solution used has to be pure. If it contained any other metal ions, these would also pass through the membrane and so contaminated the NaOH solution produced.

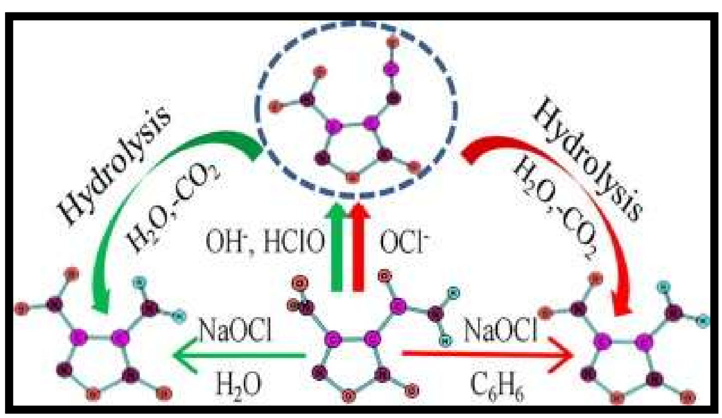


Figure 14|NaOCl reacts and produces crucial organic materials for Research Use

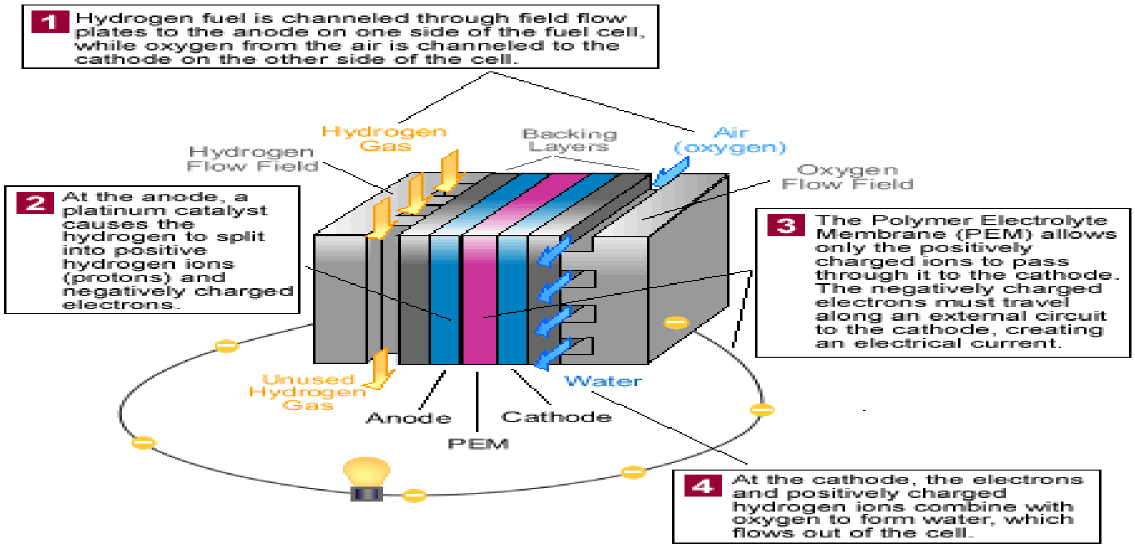


Figure 15| Fuel Cell Schematic

This (Figure 15) shows us how electricity can be generated by means of produce H_2 and O_2 gas and feed it to Fuel Cell .So it is very economically fruitful and solves the energy crisis problems also

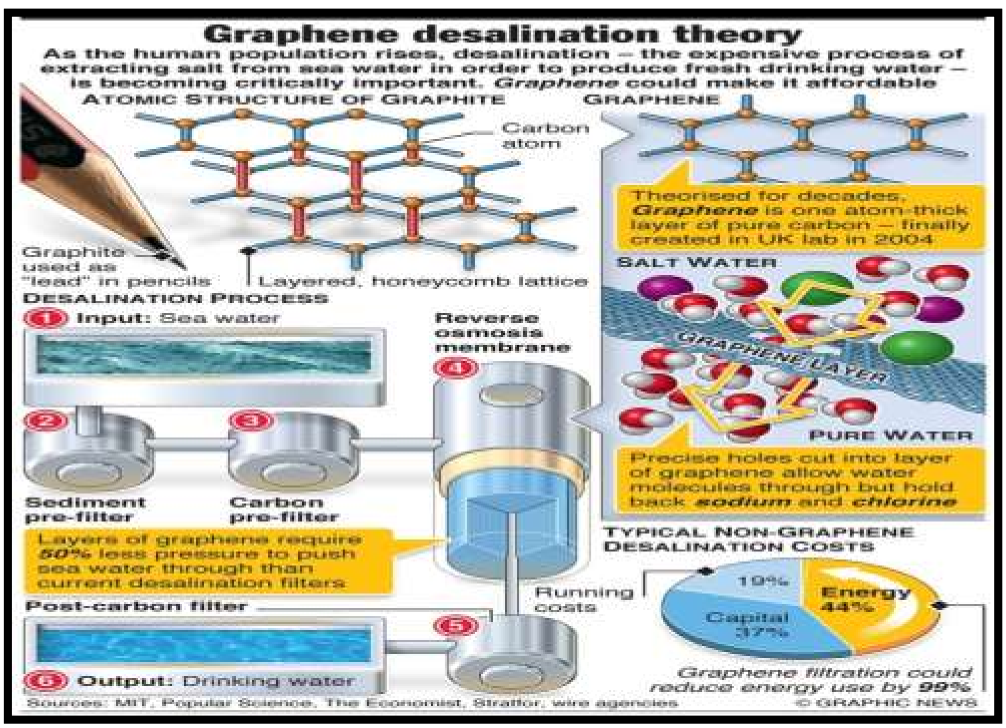


Figure 16|Graphene Desalination Theory Explanation

"Graphene Desalination Theory" is also introduced for production of Drinking water from seawater (figure 16 shows). Graphene as Graphene Oxide (GO) shows antimicrobial properties, thus lowering membrane biofouling, that is improving the membrane lifetime and energy consumption of the water purification processes. Moreover, graphene can readily be processed into a membrane for application as RO and Nano-filtration (NF) (a low-cost and highly efficient separation technique between ultra-filtration and RO) desalination membrane.

Table 2| The Palatability level of Drinking water

TDS Level (Milligram/Litter)	Palatability of Water
Less than 300	Excellent
300-500	Good
600-900	Fair
900-1200	Poor
Above 1200	Unacceptable

Note: The Palatability of Water only describes the acceptability of the taste of water. It does not mean this should be healthy or unhealthy. [**TDS** means **Total Dissolved Solids**]

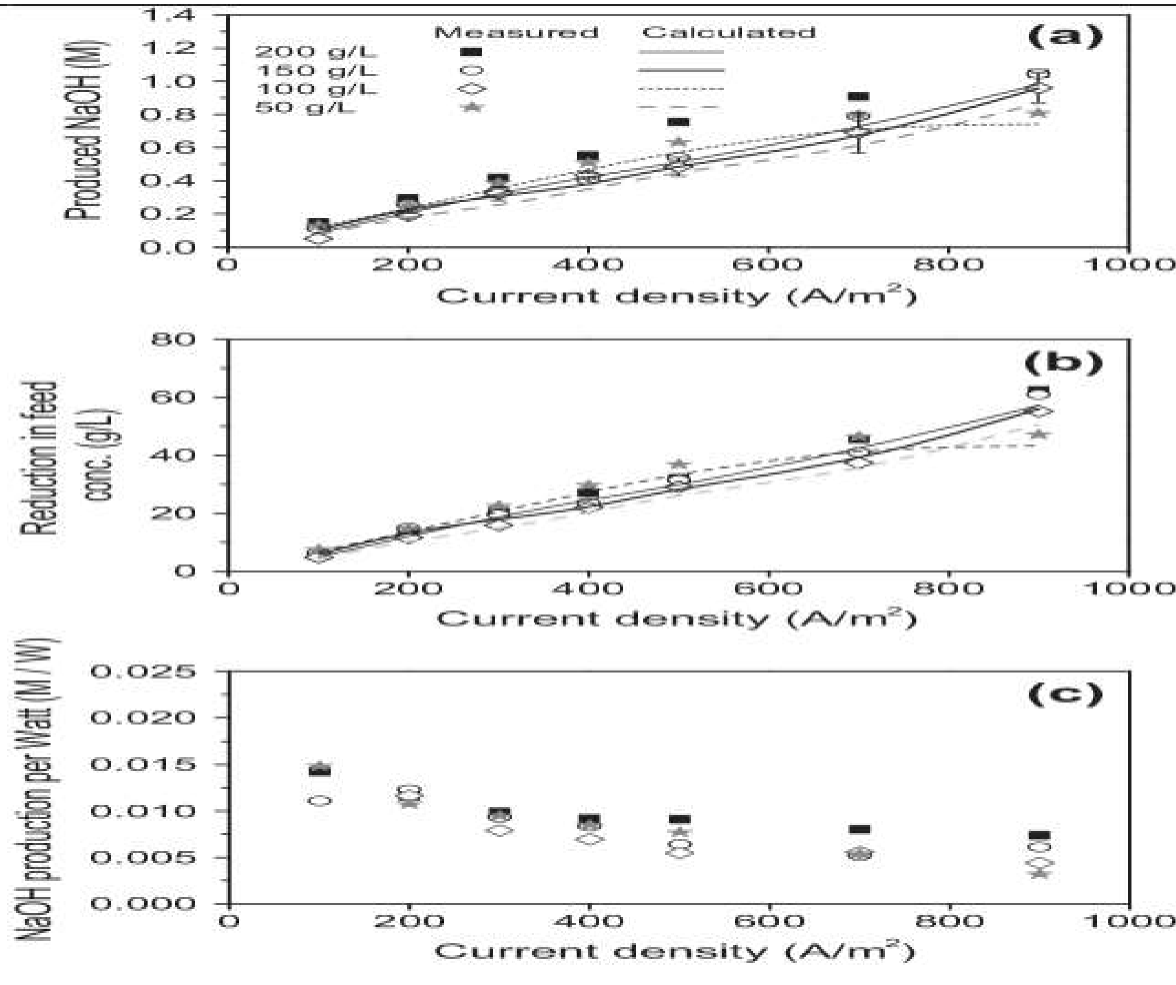


Figure 17|NaOH production rate, Reduction in the Feed Concentration graph with respect to Current Density

Above (Figure 17) shows that production of the NaOH with respect to the electrolysis Current density factor measured in practically as well as theoretically. It helps to produce the actual amount of NaOH in the industrial processing and determining the actual concentration by this graph of different dependable factors of production.

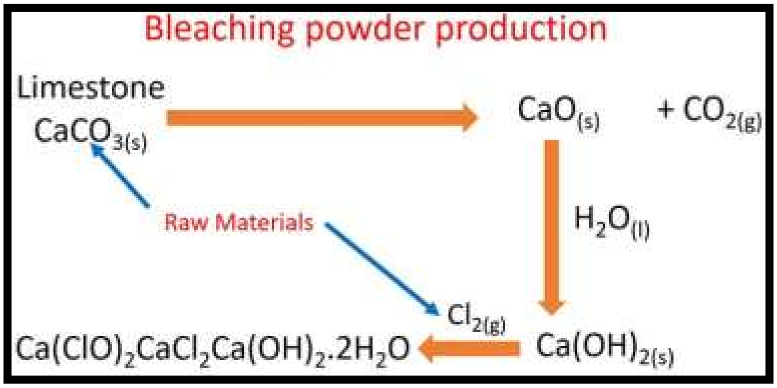


Figure 18| Bleaching Powder Production (Reaction) Diagram

This process helps us to use the produced Cl_2 gas as a raw material to use in the Bleaching Powder production (figure 18 shows). It decreases the cost of production as well as this Bleaching powder can be used as disinfectant and germicide especially in the sterilization of drinking water. It can also be used as an Oxidising agent in many chemical industries to obtain various chemical products.

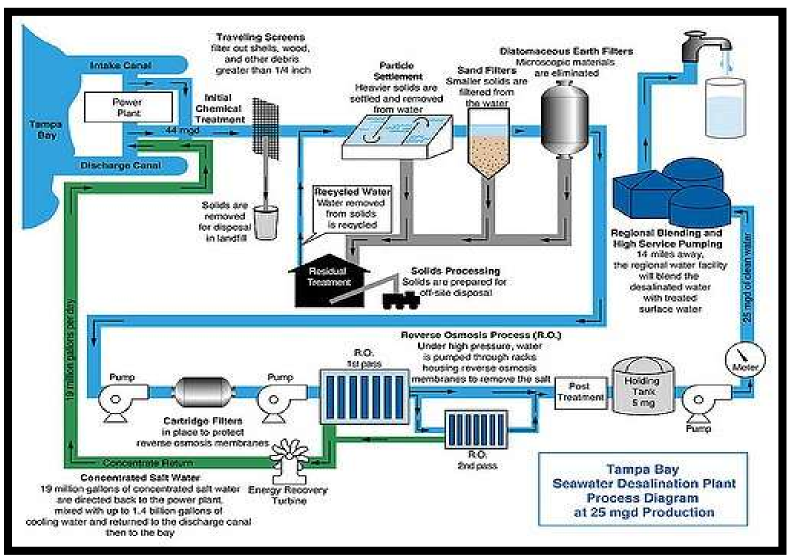


Figure 19| Tampa Bay Seawater Desalination Facility (RO Process)

This Tampa Bay Desalination Plant (figure 19 shown) a drought-proof, alternative water supply that provides up to 25 million gallons per day of drinking water to the region. But this plant uses the traditional RO process with only serving Drinking water crisis, but our proposed idea has been planed very effectively to solve more than one crisis problems and Eco-Friendly also.

Table 3|Drinking Water Quality Standards

Serial Number	Parameters	World Health Organization (WHO , 1994)
1	Color, (Hazen unit, Max)	Nil
2	Turbidity	5.0

3	pH	7.0-8.5
4	EC (μmhos/cm)	300
5	Dissolved Oxygen (mg/l)	4-6
6	Total solids (mg/l)	500
7	Dissolved solids (mg/l)	300
8	Alkalinity (mg/l)	200
9	Total hardness (mg/l)	300
10	Calcium hardness (mg/l)	75
11	Magnesium hardness (mg/l)	30
12	Chloride (mg/l)	250
13	Sodium (mg/l)	200
14	Potassium (mg/l)	200
15	Sulphate (mg/l)	200
16	Phosphate (mg/l)	0.1
17	Nitrate (mg/l)	45
18	Total nitrogen (mg/l)	1.5
19	Fluoride (mg/l)	1.0
20	Iron (mg/l)	0.3

This table shows the different components of the safe Drinking water and their amount present makes it usable for us as the Standard Guideline of WHO. The Guidelines for drinking-water quality (GDWQ) promote the protection of public health by advocating for the development of locally relevant standards and regulations (health based targets), adoption of preventive risk management approaches covering catchment to consumer (Water Safety Plans) and independent surveillance to ensure that Water Safety Plans are being implemented and effective and that national standards are being met. So this process also ensures about the standard quality of drinking water will be produced.

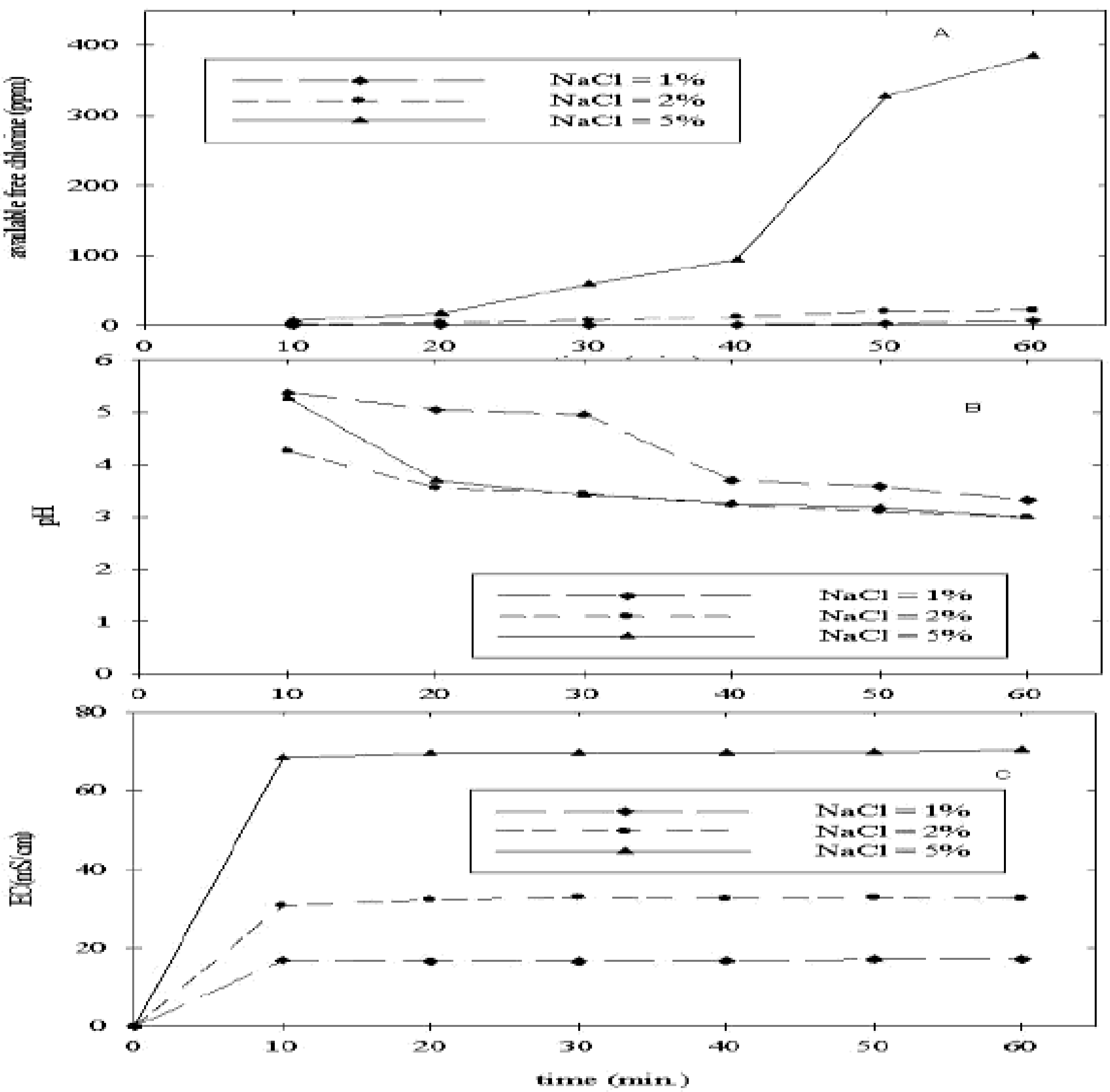


Figure 20| Graphs Cl_2 concentration, pH and Electrical Conductivity of the solution with different concentration of NaCl with respect to time

This Graphs (Figure 20) shows, how the NaCl concentration affects the brine solution during Electrolysis amount of free electron to produce the Chlorine gas (Concentration in ppm), the pH of the solution and the Electrical Conductivity of the solution over time. Those three graphs helps to know that how much time needed for exact value of concentration of Chlorine gas production with controlling the ph of the solution and the electrical conductivity helps to perform electrolysis with desired control amount of electricity.

3.4. RESULTS AND DISCUSSION

The result of this process is following.

3.4.1. *Lithium Extraction*

It gives us the lithium metal from sea which is very crucial metal. Sieve of Graphene can be used to filter seawater by using desalination of seawater leverage RO, which produces both a purified water stream and a reject stream consisting of a concentrated brine solution Actually Li is hugely present is in the $Li2CO3$ state and only this is insoluble in water and by thus reject stream we purify it and then heat it by the reaction Because more of the lithium salt does not dissolve in water. Alcohol can be also used to dissolve the Li salts. The vacuum thermal reduction helps to produce Li, from CaO which can get by the cycle (Figure 21 shows the flow diagram).

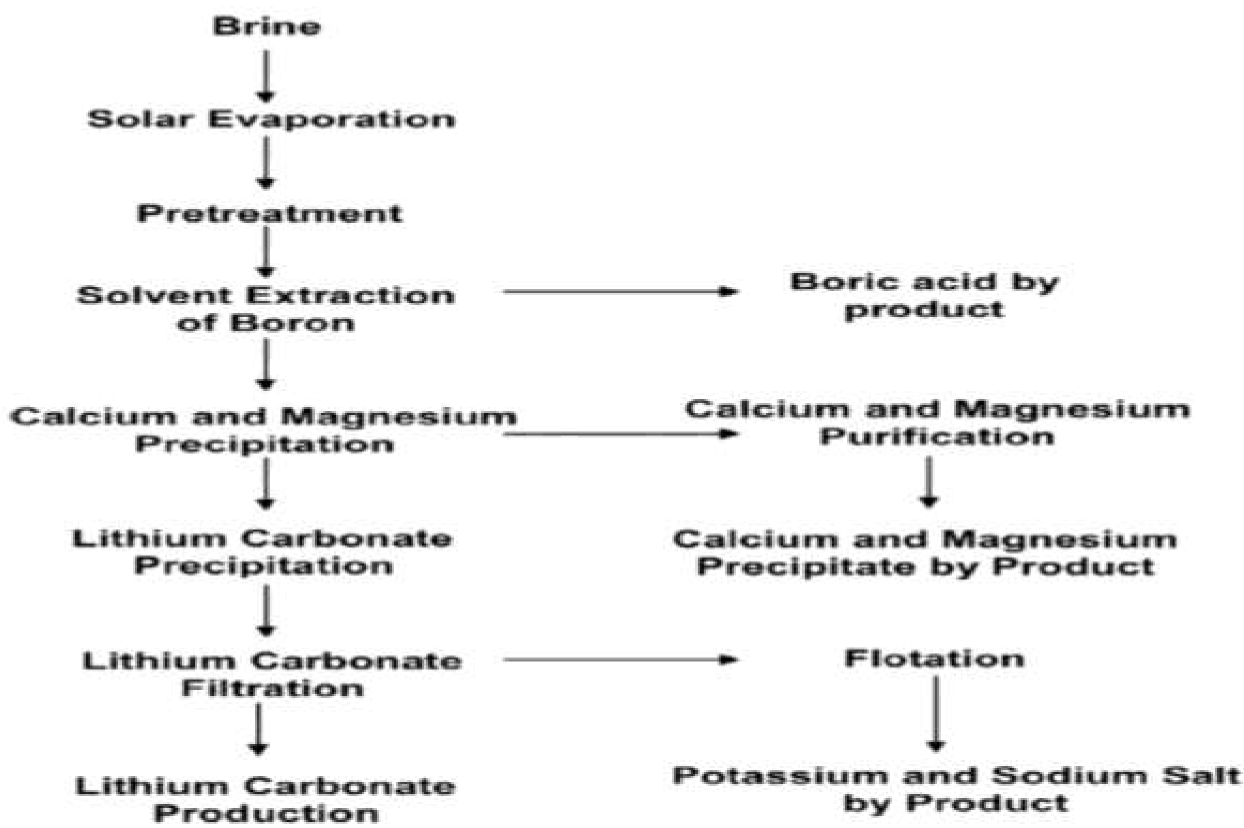


Figure 21|Flow diagram of Lithium extraction from Seawater

The below (figure 22) shows an advance process of Lithium metal Extraction by the L-M-O type ion sieve.Lithium ion-sieve (LIS) is a lithium ion adsorbent with low toxicity, low cost, high chemical stability, and high Li^{+} uptake capacity, which is considered as the most promising adsorbent. In general, LIS is classified into lithium manganese oxides (LMO) and lithium titanium oxides (LTO) types. The LMO-type LIS is the most popular adsorbent for lithium owing to its superior lithium selectivity, high lithium adsorption capacities, and excellent regeneration performance. In comparison, the LTO-type LIS has much stable molecular structure because of its large titanium-oxygen bond energy. However, compared to the LMO-type LIS, the lithium adsorption rate of the LTO-type LIS was relatively slow. More seriously, this adsorbent is of limited use in lithium recovery from aqueous solution when electrical potential is applied.

Global demand for lithium metal is projected to rise 8.9 percent per year through 2019 to 49,350 metric tons. In lithium carbonate equivalent (LCE) terms, the value of the global lithium market is projected to reach $1.7 billion. Torrid advances in the rechargeable battery market will fuel increases, driven by rapid expansion in the lithium-ion (Li-Ion) battery industry as world demand for hybrid and electric vehicles (H/EVs), energy storage systems, and high-drain portable electronics continues to grow. Rising production of primary lithium batteries will also support market gains, especially as improving incomes in emerging economies spur shifts to better performing primary batteries. In (figure 23) shown the statistical analysis of Lithium Source and uses.

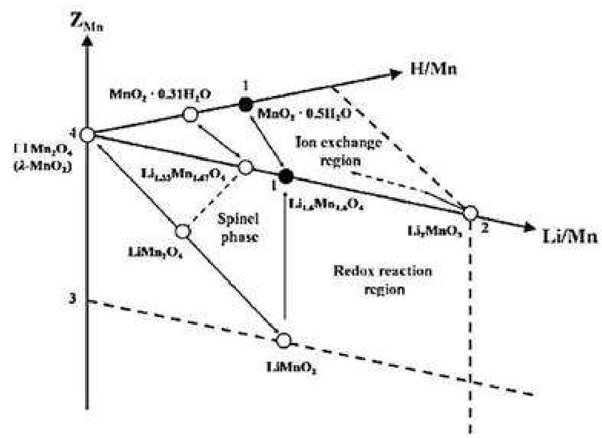


Figure 22 | Lithium metal extraction by LMO type (Ternary phase of Li-Mn-O) ion sieve

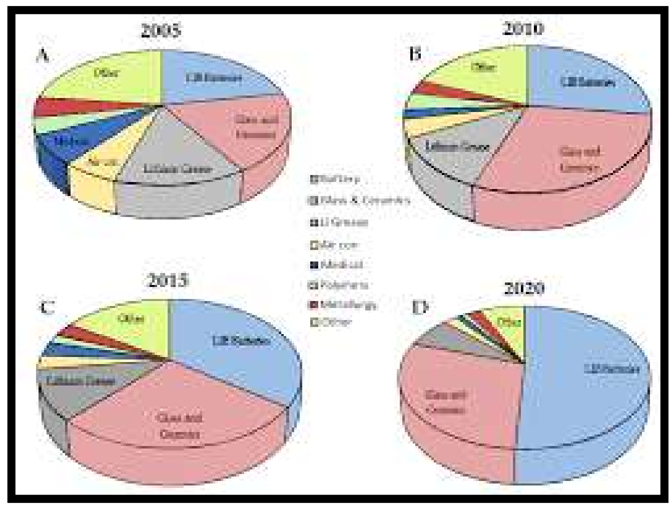


Figure 23 | Global Lithium Source and Industrial Uses for Electrical power generation

3.4.2. *Drinking Water Production*

In this process, the desalinated water that is produced from seawater, can be purified by using chlorination with the chlorine which is produced in this process. Then by Potabilisation (adding CaCO3, and other minerals for human body) is added to make it drinkable. Below (Figure 24) shows how a unique chlorination improves water treatment.

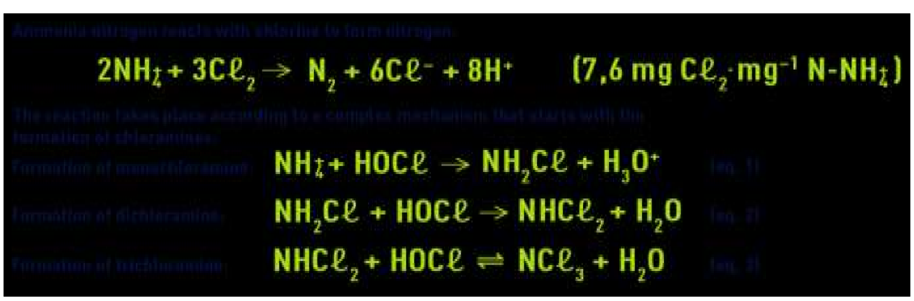


Figure 24 | Reaction of generated Cl2 for Chlorination of Drinking water

3.4.3. *Production of Oxygen At low cost*

Also by this process much amount of NaCl is produced which can be used to produce O2 at room temperature by the reaction with O3 producing NaOCl and the major O2 gas. This process can be used to produce industrial low cost O2 production as well as Oxidizing the alcohol at a low cost.

3.4.4. Production Of NaOH

Also NaOCl can be used in many way to produce O2 like at room temperature NaOCl reacts with CH_3OH (Methanol) producing CH_2Cl_2 (Dichloromethane) and NaOH and O2 . This reaction is very important because it produces the costly NaOH and also the O2. The CH_2Cl_2 is used in DCM heat engine, in food industry decaffeinate coffee and tea , in aerosol spray propellant. The recent research tells that it is found in the Asparagopsistaxiformis , a seaweed fooder for cattle that reduces their Methane production by 79% . Also NaOCl in water gives HOCl if the pH is not maintained at 9.0 and this unstable HOCl in the presence of Heavy metal cations gives HCl and O2 which are very important. The below(Fig.25) shows a very cost effective efficient way of Lignin Depolymeization by Produced NaOH with Eco-Friendly process.

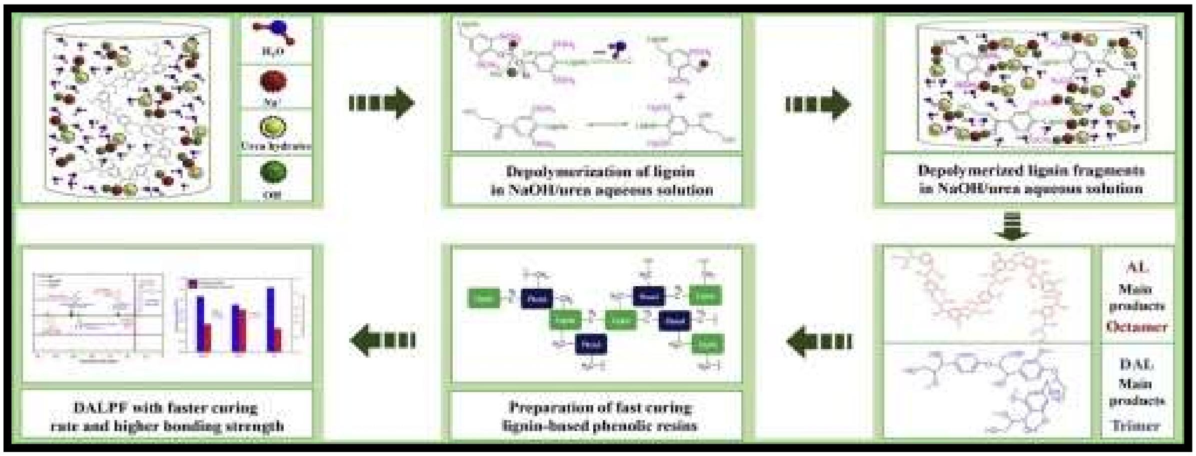


Figure 25 | Alkali Lignin Depolymerization with Eco-Friendly and Cost effective

3.4.5. Novel using of the By-product

$CaCO_3$ can be introduced in this process, which has to be heated upto 850 degree Celsius resulting CaO and CO_2. The CaO is extracted from the reaction and water is added to it for developing exothermic reactions that gives $Ca(OH)_2$ and energy. This generated energy can be used for the thermal decomposition of $CaCO_3$. The NaOH i.e. is produced in pervious step, reacts with the CO_2 emitted by Limestone ($CaCO_3$) producing Na_2CO_3 which again reacts with $Ca(OH)_2$ to give rise of NaOH and $CaCO_3$ both. This process helps to produce Bleaching powder because in the step 4; the Cl_2 reacts with $Ca(OH)_2$ at 313K. Also at high temperature it gives $CaCl_2$, $Ca(ClO_3)_2$ and water. At low temperature it gives CaCl2, $Ca(OCl)_2$ and H2O . This $Ca(ClO_3)_2$ and $Ca(OCl)_2$ acts as a bleaching agent and we can use $Ca(OCl)_2$ in Haloform reaction to produce $CHCl_3$.

3.4.6. Air Purification

The most important result of this proposed theory is to purify the air, and reduce the pollution with an Eco-friendly process to overcome the serious problem of the drinking water shortage as well as to prevent the Global warming effects .The below (figure. 26) image shows unique way to purify air by the produced NaOH in a very cost effective way. Here is the table of the constituents of purified air below.

Table 4 | Components of Purified Air

Components	Volume Percentage (Vol%)	Components	Volume Percentage (Vol%)
Nitrogen (N_2)	78.084	Methane (CH_3)	$2*10^{-4}$
Oxygen (O_2)	20.948	Krypton (Kr)	$1.14*10^{-4}$
Water vapour (H_2O vapour)	1.0	Hydrogen (H_2)	$5.5*10^{-5}$
Argon (Ar)	0.934	Carbon Monoxide (CO)	$2*10^{-5}$
Carbon Dioxide (CO_2)	0.038	Xenon (Xe)	$8.7*10^{-6}$
Neon (Ne)	0.001818	Ammonia (NH_3)	$4*10^{-7}$
Helium (He)	$5.24*10^{-4}$	Hydrogen Sulfide (H_2S)	$5*10^{-9}$

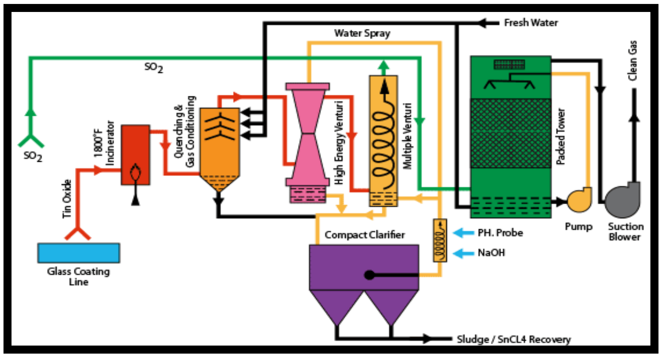


Figure 26 | Multi-Stage scrubbing system for Air purification

4. Beneficiaries

It is very beneficiary to the human beings for the source of drinking water, as well as it gives us Hydrogen gas which can be used to generate pollution less fuel and energy source, most importantly the Oxygen gas which can be used in several techniques in our Modern Day. Also it is very useful, to the Reverse Osmosis power plant to generate their own resources by consuming same sea water, along with producing likely double amount of drinking water with energy generation also. It is very important for the Chemical industries because sea water is the gull of salts and minerals as well as it contains some elements which are not yet been discovered. We can extract Lithium from sea which is very costly & rare metal which is used in most advanced energy sources like Lithium Battery power source. This process is also eco friendly as it gives the idea to purify air and to overcome the Global warming effects of increasing sea water level. This process may also help to discover so many costly elements from the seawater in future.

5. Extent of the research

PRESENT METHOD TO TACKLE THE PROBLEM

There are numerous methods to tackle the problem like reverse osmosis (Pressure applying method), desalination of sea water (By Boiling or Electrical method), Distillation methods.

PROPOSED SOLUTION

Here, from our proposed idea, an auto cyclic process is introduced by which the expensive methods can become more economically safe and easy also by means of generating power, expensive gases like Hydrogen & oxygen gas, Lithium metal extraction and air purification . This proposed process gives approximately twice amount of drinking safe water from sea water.

ALTERNATE SOLUTIONS/STEPS

There are various alternative steps to desalinate seawater but these are much expensive and energy consuming. If a very easy process can be proposed, by which only few amount of energy is consumed but producing large amount of drinking water then it will be very beneficial. Our thinking is, in future, we can make a very sophisticated lightweight machine that can readily give us drinking water from adding/feeding seawater to it, and then it will be marvelous. We are also working, how to design a nano-crystalline solution that can absorbs all the non-essential minerals and salts from seawater including bacteria then it will be very easy to be utilized in our future generation.

6. Novelty of the Proposed Theory

Our presented process has the novelty because it is a cyclic process, which can not only produce our desired product (Drinking water) but also produce very essential elements like Hydrogen gas, oxygen gas, Lithium metal and various metals and also make electricity. Mainly (1/3)rd. of produced electricity can be consumed to run the process and the rest generated power , can be utilized to tackle the energy crisis problems. In addition, it helps to purify the air in an eco-friendly process. This process does not need much Economical strength because once it is started; it produces its own supply materials with essential by-products generation. So it is very much Eco-Friendly as well as low costing process but generating costly materials(Figure 27 & 28 shows most advance and very effective Crucial metal Lithium extraction from sea water).

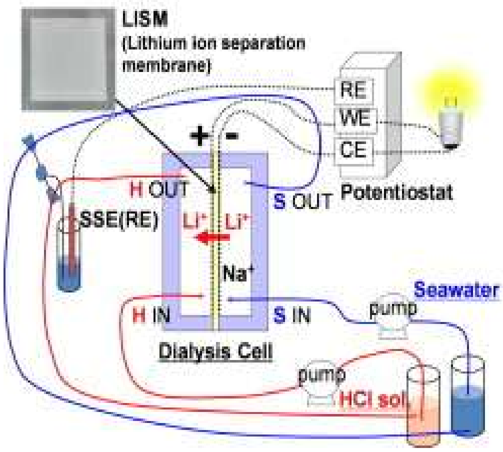


Figure 27 | The advance method of extracting lithium by LISM from Seawater

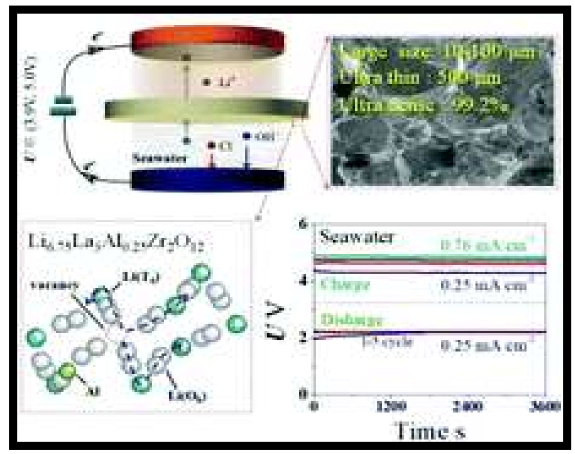


Figure 28 | The Ultra-fast Stable Extraction of lithium from Seawater via Spark Plasma sintering (SPS)

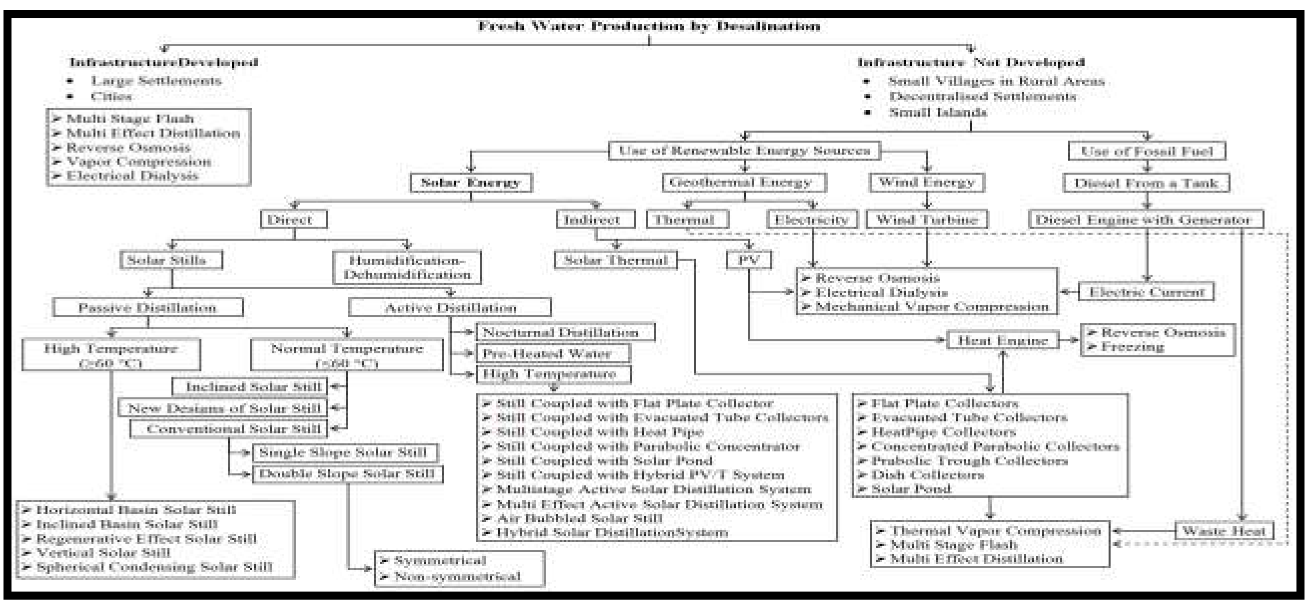


Figure 29 | Solar Power desalination of seawater for drinking water production

- This (figure 29) shows the future of the advanced desalination technology for Seawater.

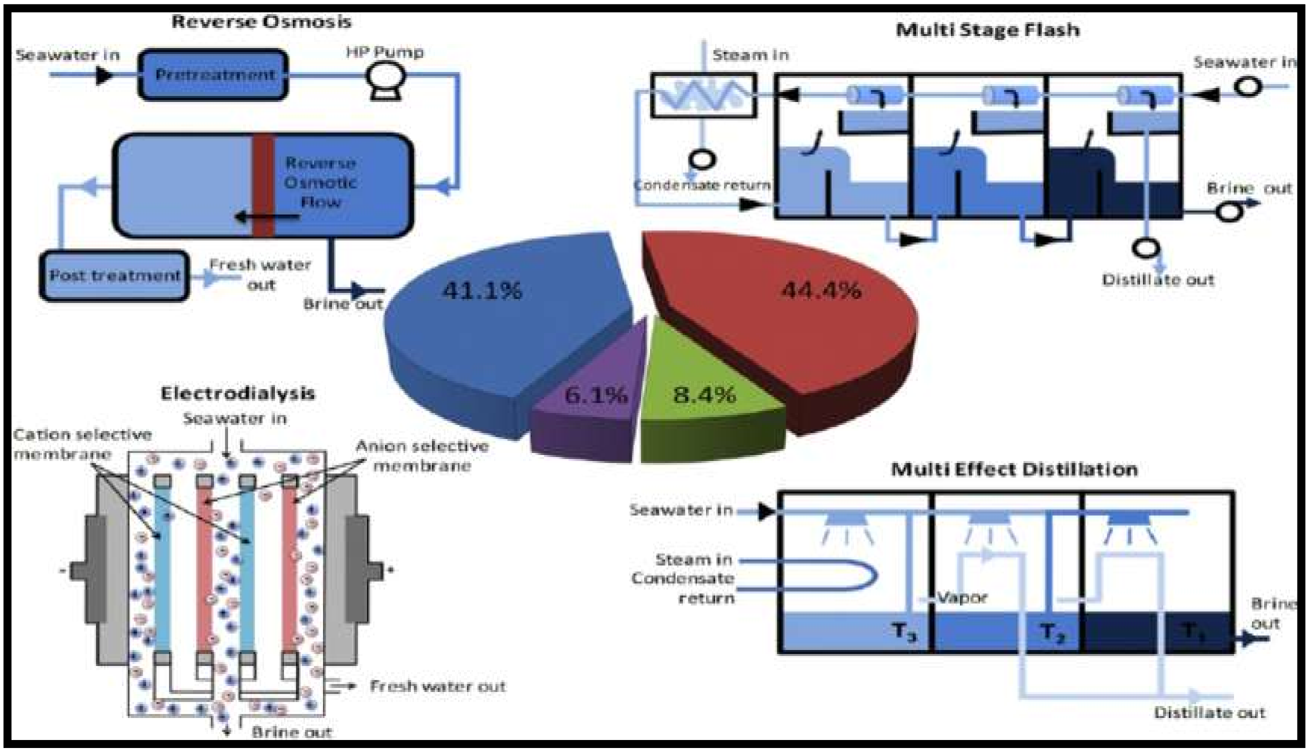


Figure 30 | This schematic shows that RO is very expensive and low efficiency process

7. Conclusion

The main background of the idea is to tackle todays and the future's critical drinking water crisis. After 20years, 47% of the World population probably will live in serious water scarcity. In such a position, Seawater is the major source of our drinking water and through this process, if we can generate electricity and energy then it will be more economically safer and easier for our society as well as Earth. The global demand for water has been increasing at a rate of about 1% per year as a function of population growth, economic development, and changing consumption patterns, along with other factors, and it will continue to grow significantly over the next two decades, resulting in water scarcity in various parts of the world (WWAP 2018). To address this challenge, extensive research must be conducted to identify advanced novel methods of water purification at lower cost with less energy. In addition, such technologies must be independent from the use of rare Earth materials and must not impact the environment. It should be done with an innovative way using the material that is present in Earth with sufficient amount or introducing new materials to secure the scarcity of earthen rare materials. So, in our conclusion it can be said, this process can generate hydrogen gas which can be used as fuel, along with the oxygen gas which is also our life supporting gas. Also, it can purify the air to reduce pollution, generating electricity and the most important aspect, the drinking water production at a cheap cost then it will be the best idea to tackle today's burning problems. This theory is only proposed to make a possibility of producing drinking safe water from sea as well as producing some other valuable by-products in an efficient process. Finally yet importantly, in the large-scale controlled progress of this process for industrialization is still a challenge and needs further study in the next decades.

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